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Using step-by-step engines to determine the course of the ship

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Abstract: Stepper motors are execution elements with the digital-analogue electromechanical converter function and their use is obvious in numerical control and regulation systems. Step-by-step motors convert directly of the input signal, given in numerical form, in a discontinuous or incremental angular motion. The motion of the set object is quantized in discontinuous displacements, in full consistency with the evolution of discrete command signals. Positioning fidelity made with a step-wise motor will depend on the rotor geometry and when using a servomotor, the accuracy will depend on the reliability of the potentiometer and other analog components in the engine's feedback circuit. The stepper motor rotor movement consists of discrete angular displacements, successive, of equal sizes and representing the steps of the engine. Any change in the course of the vessel results in a change in the angular position of the tracking element relative to the meridian.

1. Introduction

The stepper motors are construction elements with the digital-to-analog electromechanical converter function and their use is obvious in numerical control and numerical adjustment.

The stepper motors convert the input signal directly, given in numerical form, in a discontinuous or incremental angular motion. Movement of the adjusted object is quantized in discontinuous displacements, in full consistency with the evolution of discrete command signals [1].

The stepper motors are essentially digital. The rotor executes an incremental motion, from an equilibrium position to the next while the stator winding corresponding to the second position, closeness, is driven by an electric current [2].

The magnetic field required for stepper motor operation can be created in several ways. Frequently used engines with variable reluctance VM (Variable Magnet), in which the magnetic field was created by the coils, corresponding constructed, wrapped on a fixed stator. One of the most common types of motors is the Permanent Magnet motors PM, in which the magnetic field is created by a permanent magnet. Hybrid motors are, to a certain degree, a combination of ideas of VM and PM engines, but which differ in better resolution, as a bigger moment and speed [3].

The stepper motors allow for discrete-type adjustment systems, which has the remarkable advantage not need reaction loops to correct the movement, very good torque / position ratio and the maintenance effort that exists when the engine is not powered and is in a strong magnetic field [4].

For different applications, a servomotor or a step-wise motor is possible to used. Both types of motor are used for precise positioning but the servomotors require analogous reaction control systems [5].

IOP Conf. Series: Materials Science and Engineering **591** (2019) 012105 doi:10.1088/1757-899X/591/1/012105

This implies the use of a potentiometer to control the position of the engine but also a circuit that will power the motor with a current which is inversely proportional to the difference between the desired and the current position. In choosing to use a servomotor or a step-by-step motor, more characteristics are considered and choose depending by the chosen application.

Positioning fidelity made with a stepper motor will depend on the rotor geometry and when using the servomotor the accuracy will depend on the potentiometer's reliability and the other analogue components from the engine's feedback circuit [6].

The rotor movement of the step-by-step motor consists of discrete angular displacements, successive, of equal sizes and which represent the steps of the engine. Number of steps conducted must correspond to the number of control pulses applied to the engine phases.

At each impulse, the rotor performs an angular step, then stops until a new impulse arrives.

The stepper motor is capable of reversing the motion.

If it is correctly commanded (with less frequent than the acceptable frequency), it remains in sync with the control pulses to accelerate, steady, and slow down.

The total angular displacement which is consisting of a number of steps equal to the number of control pulses applied to the engine phases, determines the final position of the rotor. This position is preserved until a new command pulse is applied. The unequivocally of pulse-displacement conversion, associated with memorizing the position, make the engine a good execution element, integrated in position regulation systems in open circuit.

The stepper motors present the property to be able to get into synchronicity toward the control pulses even from pause condition, operating without slip and braking is made, also, without leaving the state of synchronism. On the strength of to this, it is assured the starts, the stops and sudden reversals without losing of steps across the work area.

The speed of the stepper motors will be a function the frequency of activation of the stator windings.

There are a number of characteristics that make these engines to be represented the first choice [5].

- there are capable of operating with precision reference in automated systems in an open loop. This inherent accuracy eliminates the need for position transducers or speed and, thus, reduces the total system cost;
- it can produce large mechanical torques at low angular speeds, including stops, hybrid stepping motors;
- it can produce couples to maintain large mechanical loads through feeding the windings in direct continue current;
- the operation of these engines and associated drive circuits is effectively digital what it allows a relatively simple interface with a microcontroller or a computer.

The repeater giro and receivers embedded in other electrical navigation apparatus receive a set of tensions containing the course of the ship. These synchronous receivers it represents the course reference for the assessment of other navigational information.

The existence of circular repeaters in the ship's bordering is justified by the necessity of taking over landmarks using in combination with the giro repeater the navigation instrument which is known as "alidade".

This configuration is a requirement imposed by international ship registers.

2. The presence of synchronous receivers is giro on board the ships

Instant knowledge of the giro course is required mandatory, as required by the regulations and ship registers settlements, in the following compartments, like figure 1:

- Command bridge/pilot house - Sailing boat/Automatic pilot
- Command bridge/boards - repetitive bearing
- The lower deck/The rudder room – repeaters for damage governance [7].

The repetitive of bearing from boards are equipped with roses by 360° and 10°, coaxial position, to view the giro course.

IOP Conf. Series: Materials Science and Engineering **591** (2019) 012105 doi:10.1088/1757-899X/591/1/012105

There is another repeater in the commander's cabin and giro receivers in the map room for the course recorder and radiogonometer.

Also, the radars are equipped with reference giro receivers.

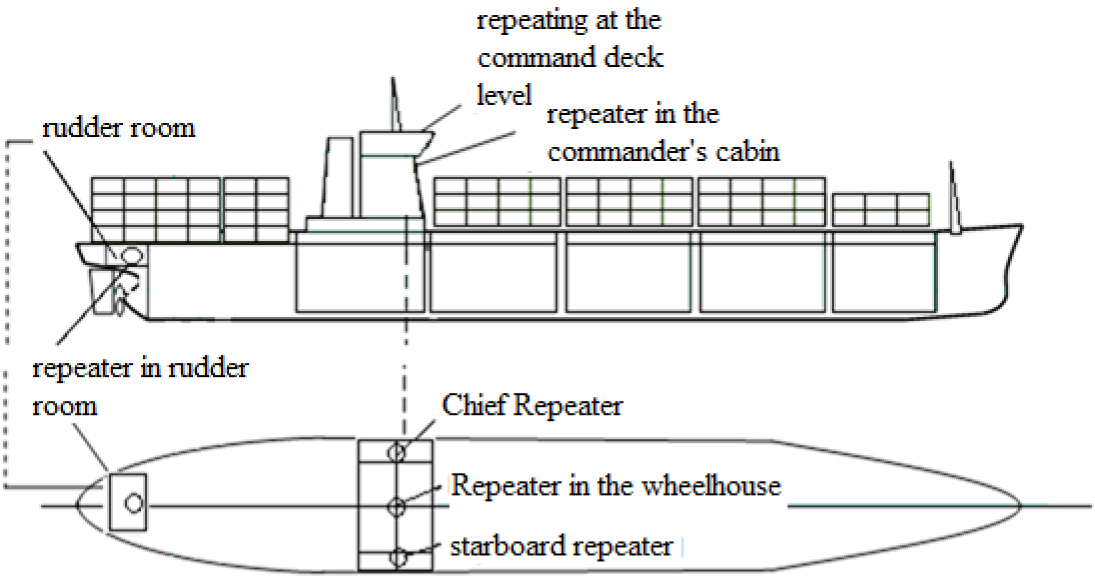

Figure 1. The presence of synchronous receivers is giro on board the ships.

3. Component of link of the giro transfer

The alteration of the ship's course is obtained through of a sensitive element of the electric navigation apparatus which is being followed by a portion of the sampling interface, that is, a element for follow like figure 2.

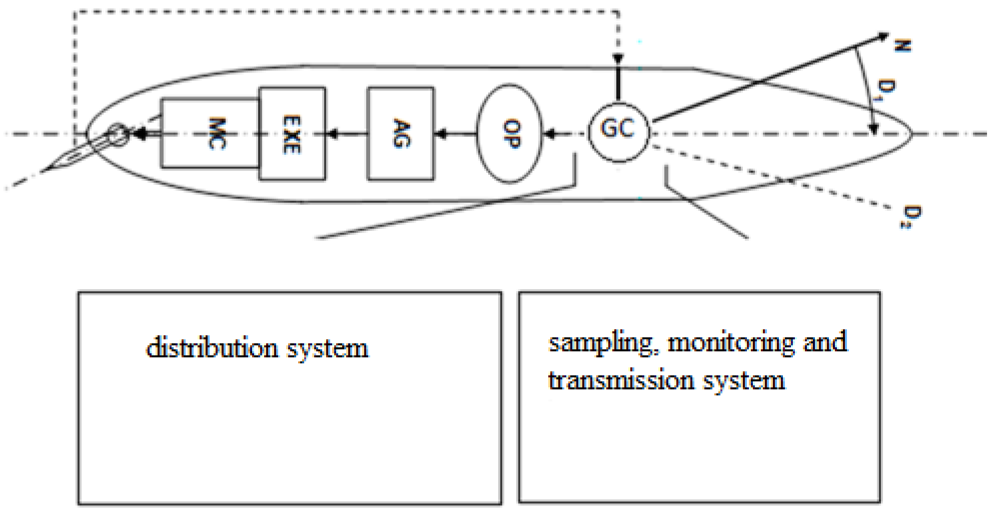

Figure 2. The component of link of the giro transfer.

Sensitive element (SE) initiates delivery of input size RLΔΨ for the following system, and the following element (FE) is an ordered object and informative semi interface.

The tracking element is usually solidary with the coarse indicator of the course giro of the ship. (DISPLAY SYSTEM OF THE COURSE) Ψ [8].

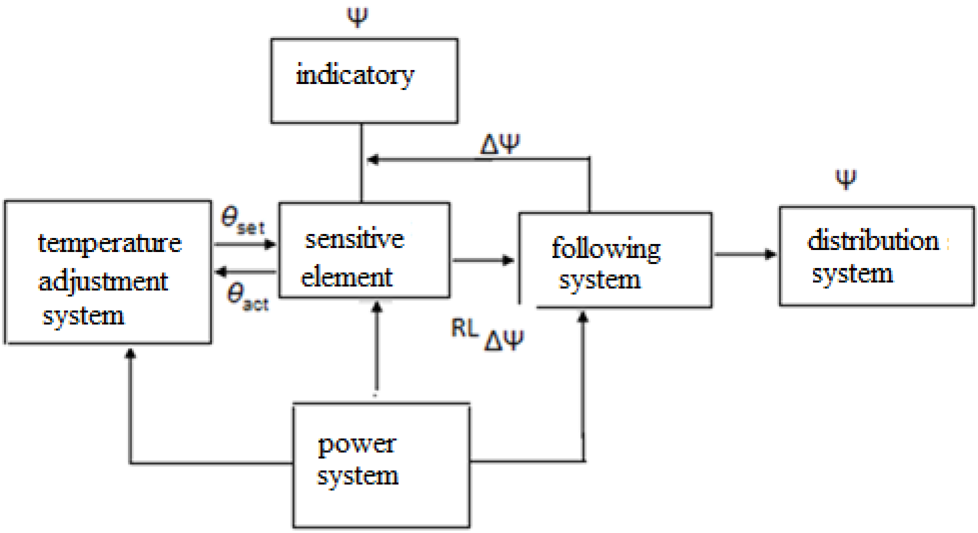

Figure 3. The structure of the giro equipment.

The structure of the giro equipment is presented in figure 3:

- The assembly sensitive element - following element (SE-FE);
- The following system;
- The distribution system for information relating to alteration of the ship's course;
- The power supply system;
- The adjustment system for the temperature of the environment [9].

The signal of course differences $\Delta\Psi$ is taken from the bridge formed by primary windings L_1, L_2, of the symmetrical transformer (TR) and two variable resistors R_{W1}, R_{W2}, of the liquid support, (which is formed between the captive contacts of the following sphere and the ends of the conductive equatorial band of the giro sphere) in series with two resistors R_1, R_2, of the liquid columns between the equatorial conductive surfaces and the inferior conductive dome of the giro sphere, like figure 4.

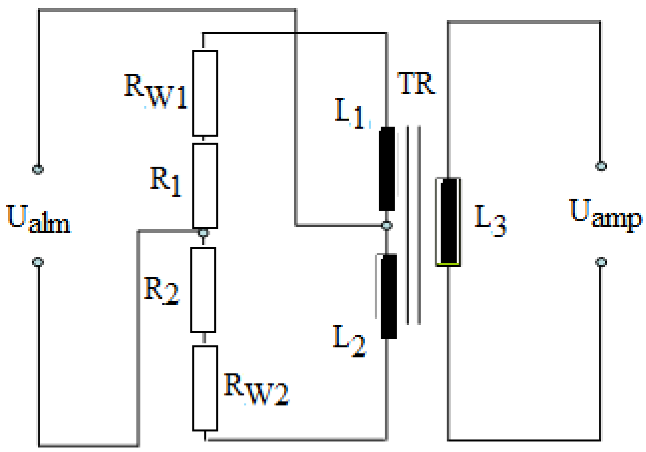

Figure 4. The electrical scheme.

Any change of the ship's course (Ψ) has like a result a changing the angular position of the following element (following sphere) to the sensitive element oriented in the meridian.

This mechanical change it translates in the unbalance of the Wheatstone bridge which has two resistive elements in its composition (R_{W1} şi R_{W2}) represented by the liquid support columns

IOP Conf. Series: Materials Science and Engineering **591** (2019) 012105 doi:10.1088/1757-899X/591/1/012105

(interstitial environment) between the following electrodes of the following sphere and the gyroscopic equatorial conducting band.

Inequality of resistance values of liquid columns generates the current inequality which crosses the primary windings of the symmetrical transformer and, as a result the occurrence of a voltage with a certain phase in the secondary of the transformer, see equation (1).

$$\underline{I}_1 R_{W1} + \underline{I}_2 R_{W2} \neq 0 \Rightarrow \underline{U}_{amp} \neq 0 \tag{1}$$

This voltage is compared to a reference (u_{ref}) and amplified before being applied to the following electromotor.

$$\underline{U}_{serv} = k\left(\underline{U}_{amp} + \underline{U}_{ref}\right) \tag{2}$$

The direction of rotation and its number of revolutions must compensate by demultiplexing the angular difference between SE and FE, like equation (2).

The transfer function made of the transmitter is given in equation (3):

$$\chi_T = \frac{u_{\Delta\Psi}}{\Delta\Psi}\left[\frac{Volt}{\deg ree}\right] \tag{3}$$

The distributor is an energy pumping node.

Its yield is given by the relationship presented in equation (4):

$$\eta_{distr} = \frac{\sum P_{rec}}{P_{cons}} \tag{4}$$

Giro repeaters and receivers embedded in other electrical navigation devices receive a response.

These synchronous receivers represent the course reference to evaluate the other information related to navigation [10].

The route of the ship can be monitored using the course recorder.

Giro sphere, floating freely in the carrier liquid, inside the following sphere, requires a power supply at 55V / 400Hz, for the two gyro engines, so that they can spin with a constant speed of about 12.000 rpm.

4. Conclusions

The speed of a stepper motors can be adjusted to wide limits by changing the input pulse frequency.

The stepper motors are used in low power applications characterized by movement fast, accurate, repeatable.

The stepper motors also has the property of being able to get into synchronism to the control pulses even in the resting state, running without slipping.

Their braking is carried out by also without leaving synchronism.

Because of this fact is ensured starts, stops sudden reversals without loss of steps throughout the work area.

The stepper motor is a device for converting numerical information into mechanical work based on a power consumption from a source.

The stepper motor is a digital control motor with angular displacement of the rotor proportional to the number of pulses received.

IOP Conf. Series: Materials Science and Engineering **591** (2019) 012105 doi:10.1088/1757-899X/591/1/012105

Stepper motors can be used in a bi-axial positioning system for positioning accuracy and to avoid an active adjustment mechanism, delivering a higher torque, which makes them useful. Transmission ratios can be calculated geometrically in the simplest case, dividing the diameter of the motor spindle into the diameters of the two disks in the gears.

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